Description

# A Plug Connector for Electrically Connecting Electronic Components

The invention refers to a plug connector, for example a socket board or a plug board, for electrically connecting electronic components.

Complex electronic circuits generally consist of several assemblies, such as plug-in cards or accessory devices, for instance drives for bulk storages, which each contain printed circuit boards (PCBs) and which are usually electrically interconnected for producing the function of the circuit. Cables are used for generating this electrical connection which at their ends comprise standardized plug connectors, namely one- or multi-polar sockets or plugs. Appropriately corresponding counterparts are provided at the assemblies to be connected, so that the plug connectors of the cables can be connected to the plug connectors of the assemblies. The plug connectors of the assemblies, for instance socket boards or plug boards in general are connected mechanically and electrically to a printed circuit board (PCB) pertinent to the respective assembly.

The mechanical connection between plug connector and PCB is necessary in particular with vibration-loaded circuits, as they can be encountered for example in the automotive region, in order to ensure reliability of the connection.

The electrical connection of the plug connectors to the respective PCB takes place by soldering, while the mechanical connection takes place by screwing, riveting or

by comparable joining technologies. This double connection of the plug connectors to the PCB leads to redundance in storage, which - in particular due to the thermal expansions of the soldering partners caused by the soldering - may lead to distortions, which can impair the function of the electronic circuit.

Therefore, in series production of electronic circuits at first the SMD process (SMD = surface mounted device, mounting of the printed circuit board with components and soldering of the same) is performed.

Only subsequent thereto the plug connector(s) is/are initially connected to the PCB mechanically by means of screwing or riveting. Afterwards, the plug connector is connected electrically to the PCB by soldering and the latter is connected to the housing.

If mechanical fastening of the plug connector(s) was performed after the electrical connection, powers would act upon the contact elements, which are already rigidly connected to the PCB, of the plug connector(s), which excite distortions in the material and thus could impair or prevent the function of the circuit.

According to this, in series production of electronic circuits for producing a PCB, which apart from other electronic components is to contain also one or more plug connectors, several work steps for mounting the plug connector(s), namely manual fitting with components, fastening or soldering, must follow the SMD process.

For this purpose additional fastening elements, such as

screws, rivets or the like are required. For fastening the PCB at the housing additional screw-down points are required, involving increased requirements to space.

Starting from this state of the art it is the object of the present invention to propose a plug connector, which can be fastened to the PCB after soldering, without distorting the contact elements and simultaneously making use of their fastening points for connecting the PCB to the housing.

The invention is achieved in accordance to the invention by a plug connector with the features of claim 1; advantageous further embodiments are described in the sub-claims.

The plug connector for electrically connecting electronic components comprises one or more contact elements as well as a housing, which consists of a lower part and of an upper part that can be joined to said lower part. The contact elements are contained between the lower part and the upper part in the joint state to protect against contamination or mechanical loads, whereas the lower ends of the contact elements project through openings located in the housing, and the upper ends of the contact elements can be contacted via openings located in the upper part of the housing. In accordance with the invention the respective contact element of the plug connector is formed from at least three limbs which extend in a stepped manner inside the housing, one of the limbs being flexibly arranged inside a cavity formed between the upper part and lower part. Consequently, by the limb arranged in the cavity a bending deformation of the respective contact element is possible.

In other words: The plug connector comprises for example one or more three-limb contact elements (also called "contact pins" or in short "pins"), the respective contact element in the region of a first and second limb, which in known manner each form one end of the contact element, being embodied as a small metal strip or wire nail for contacting and in the region between the first and the second limb a third limb for connecting the two outer limbs and for positioning the contact element in the housing being embodied as a metal strip.

In case of a socket board the respective contact element is embodied in known manner as a claw, for instance of several elastic metal strips, and in case of a plug board it is embodied as a small metal strip or a wire nail. Here, one of the outer limbs is embodied as a so-called male contact, i.e. contacting takes place via the outer surface of the limb, whereas the other outer limb is embodied as a so-called female contact for contacting at the inner surface of the limb. In other words: One of the outer limbs is embodied e.g. as a pin for outside contacting (= male contact) and the other outer limb is embodied as a cavity for inside contacting (= female contact). In a possible form of embodiment the respective contact elements serve for contacting or for generating an electrical connection of the plug connector to a PCB and to a plug to be connected thereto or to a cable to be connected. In this case one of the outer limbs of the respective contact element is embodied for generating electric contacting between the plug connector and a corresponding plug connector of a connection cable or the like and the other outer limb is embodied for generating electric contacting between the plug connector and conductors or a

corresponding plug connector of the PCB. The two outer limbs forming the ends of the respective contact element extend staggered at a distance from each other and parallel to each other and the middle limb is contained in-between, so that they jointly extend in a stepped manner inside the housing or extend z-shaped as far as possible.

In a preferred form of embodiment of the plug connector the middle limb with the two outer limbs enclose an angle of approximately the same size. Preferably, the limbs enclose an angle of 90° to 135°. By means of this the middle limb is flexibly arranged in type of a spiral spring in the cavity between the upper and lower part of the housing. This ensures that mechanical loads, which appear when fastening the plug connector, can be absorbed easily and safe by the middle limb embodied as a spiral spring, so that the outer limbs effecting the contacting are not damaged.

For a particularly cost-efficient and simple production of the plug connector the respective contact element is preferably formed in one piece. In a particularly simple and cost-efficient form of embodiment several contact elements are uniformly embodied and are arranged in the housing at a uniform distance from each other, in particular forming a contact row.

For mechanical fastening the plug connector onto the PCB conventional fastening means ,such as screws, rivets or the like can be used. Advantageously, for this purpose the lower part of the housing comprises in known manner at least two bores, which can be used for connecting the housing to the PCB by means of screws, rivets or similar

fastening means.

For preliminarily fixing the plug connector to the PCB between the work steps fitting with components and soldering the lower part of the housing of the plug connector comprises in an advantageous embodiment at least two fixing elements. Such fixing elements can be e.g. plastic tongues with a lateral shoulder, which are formed in one piece with the lower part of the housing, which extend in the same direction as the outer limbs of the contact elements and which taper towards their free end. Here, the plastic tongues can be inserted into bores provided at the PCB for this purpose while overcoming an elastic resistance originating from the plastic tongues due to an oversize of the shoulders in relation to the bore distance.

Here, the distance of the bores is chosen such that the plastic tongues are inserted into the holes as zero force as possible, the shoulders of the plastic tongues requiring, however, a largely low joining force. Consequently, for inserting the plastic tongues an albeit low joining force is necessary. After having passed the material thickness of the PCB, the plastic tongues spring back into their relaxed position, the shoulders of the plastic tongues preventing falling out of the plug connector, as long as they are not deformed by an outer force in like manner as it happens when inserting the plastic tongues into the bores.

Examples of embodiment of the invention are explained in detail in the following taken in conjunction with the drawing.

Fig. 1 shows a plug connector in a perspective view,
Fig. 2 shows a plug connector in a longitudinal section,
Fig. 3 shows a plug connector in a longitudinal section,
Fig. 4 shows a contact element in a longitudinal section, and
Fig. 5 shows a cut V-V through the plug connector according to Fig. 3.

In all figures like elements refer to identical reference numerals. The terms "up" and "down" used in the following refer to a plug connector according to the invention, which from the observer's view is mounted in standing or lying manner onto the upper side of a horizontal PCB. Alternatively, the plug connector can also be mounted onto the lower side of the PCB in a type and manner not shown in detail.

A plug connector 1 is shown in Fig. 1 in a perspective view. The plug connector 1 comprises a housing 2, which consists of a lower part 3 and of an upper part 4. Concretely, the shown plug connector 1 is a socket board provided for fastening onto a PCB, which has several contact elements 6 (also called contact pins or in short pins) staggered arranged for example in two parallel rows such that a perpendicular dropped from a contact element 6 of a row to an adjacent row extends between two contact elements 6 of the adjacent row. Depending on type and function of the plug connector 1 it can comprise only one row of contact elements 6.

In the closed state of the plug connector 1 the contact elements 6 are embedded into the house 2. The housing 2, in

particular the upper part 4 comprises openings O with joining aids H, which are arranged at the upper side of the housing 2. Here, one end of one of the contact elements 6 is arranged in the respective opening O. Contact elements, which correspond to the contact elements 6 of the plug connector 1 and which are not shown in detail, of another plug connector or of a connection cable, can be inserted through the openings O, so that they come into electrical contact at the upper part 4.

In addition, the housing 2 comprises at the lower part 3 also an opening O, through which the contact element 6 project with the opposite end from the lower side of the housing 2 and permit for example an electrical connection to a PCB or to another plug connector not shown. Depending on type and embodiment of the plug connector 1 it can comprise per contact element 6 a separate opening O on the upper and lower side of the housing 2 or a big corporate opening O for several contact elements 6.

At the longitudinal ends of the housing 2 mounting links 7, formed in one piece with the upper part 4 of the housing 2, with bores 8 are located for mechanically connecting the plug connector 1 to the PCB.

Furthermore, at two diagonally opposing corners of the housing 2 and formed in one piece with the lower part 3,the housing 2 comprises fixing elements 9, which extend in the same direction as the ends of the contact elements 6 projecting from the lower part 3 of the housing 2. The fixing elements 9 are plastic tongues with a lateral shoulder, which taper towards their free end. Tapering is illustrated in the example of embodiment by a partly

conical surface in the type of a frustum K.

In Figs. 2 and 3 the plug connector 1 is shown in a longitudinal section. The contact elements 6 are contained between the lower part 3 and the upper part 4 of the housing 2, the upper part of the each contact element 6 being stuck in a contact bag 10, which opens towards the upper side of the upper part 4 of the housing 2 into the openings O of the upper part 4 with the joining aids H. Fig. 4 shows an enlarged cut-out of Fig. 3 with an individual contact element 6 in a longitudinal section and Fig. 5 shows an enlarged cut-out of Fig. 3 with a fixing element 9 in cross-section.

The contact elements 6 contained between lower part 3 and upper part 4 of the housing 2 are subdivided into several limbs 61, 62, 63, which together form the respective contact element 6. For contacting the ends of the respective contact element 6 two outer limbs 61 and 63 are provided, which open into the opening in the upper part 4 or which project from the opening O of the lower part 3, respectively. The two outer limbs 61 and 63, forming the ends of the respective contact element 6, extend parallel and staggered at a distance to each other approximately in the same direction, for example vertically. A middle limb 62 contained or arranged between the two outer limbs 61 and 63, encloses with the respectively adjoining outer limb 61 and 63 an approximately equal-sized aperture angle $\alpha$. Advantageously, this aperture angle $\alpha$ has a size of 90° to 135°, however, also other aperture angles $\alpha$ are possible.

The respective contact element 6, in particular of one of the outer limbs 63 and the middle limb 62 are formed in

known manner as small metal strips. Here, the outer contacting limb 63 serves as a male contact in form of a pin or a metal strip. The other outer limb 61 is formed e.g. as a claw of several elastic metal strips and thus serves as a female contact. The entire contact element 6 is preferably formed in one piece as a sheet metal pressed piece. The outer limbs 61 and 63 thus serve for generating the electrical connection of the plug connector 1 to a PCB on the one hand, and on the other hand for generating the electrical contact to a corresponding plug connector of a connection cable or the like, the middle limb 62 being formed as a spiral spring for absorbing mechanical loads.

The housing 2 consisting of the lower part 3 and the upper part 4 which can be joined thereto, contains the contact elements 6 as shown in Fig. 3, between the upper part 4 and the lower part 3 in the region of the middle limb 62 of the respective contact element 6 a cavity 11 being located, which allows for a bending deformation of the middle limb 62. With conventional plug connectors of this type, which at first are connected mechanically to the PCB, tensions are induced in the material by soldering or subsequent cooling-down, as the conventional, straight contact elements are prevented from expansion by the rigid edge conditions caused by the fixing between the upper and lower part.

In contrast thereto, with the plug connector 1 according to the invention, the material tensions resulting from the thermal expansion of the contact elements 6 can be reduced by the elastic effect of the middle limb 62 of the respective contact element 6 so far that they do not disadvantageously impair the function of the electronic

circuit. The rigid edge conditions, which rule out such compensation in case of conventional straight contact elements, are compensated in case of the plug connector 1 according to the invention by the deformability of the middle limb 62 of the respective contact element 6.

The respective contact bags 10 have a diameter, which allows for the reception nearly free from play of the outer limb 61 of the appropriate contact element 6. In this case, the opening O in the upper part 4 of the housing 2 has a smaller diameter than the contact bag 10. Thereby, the outer limb 61 is supported upwards at the material containing the opening O of the upper part 4. Downwards the outer limb 61 is supported on a distance retainer formed in one piece with the lower part 3.